Evaluating Water Use and Management of Center Pivot Drag-line Drip Irrigation Systems

Charles Swanson – Extension Program Specialist
Texas A&M AgriLife Extension Service
College Station, Texas

Dr. Guy Fipps, PE – Extension Agricultural Engineer
Texas A&M AgriLife Extension Service
College Station, Texas

Dr. Charles Hillyer – Extension Specialist
Texas A&M AgriLife Extension Service
Amarillo, Texas

Abstract. *Center pivot irrigation is the most popular irrigation method used in Texas. Over the last 15 years, more farmers have gradually switched from furrow to center pivot irrigation. Center pivot drag line drip irrigation systems or Precision Mobile Drip Irrigation (PMDI) have gained attention in recent years because of their ability to combine the application efficiency of drip irrigation with the operational efficiency of center pivot systems. However many farmers are hesitant to implement this technology, unsure if the costs of installation and management will result in significant water and costs savings. This paper will review farmer management of such systems and attempt to quantify irrigation water use and perceived water savings from implementing this technology concept.*

Keywords. Center pivot, drip irrigation, drag-line systems

Background

The use of drip irrigation technology with center pivot irrigation machines is not a new concept. However, recently manufacturers and local irrigation dealers in Texas have started marketing drip irrigation packages for center pivots, often referred to as “drag-line drip irrigation systems” or “precision mobile drip irrigation”. These systems drag varying lengths of drip irrigation tubing behind the machine applying water slowly on the surface. The combination of these two technologies has potential to combine the higher application efficiency related to drip with the operational and maintenance benefits of center pivot machines.

A survey of growers with installed center pivot drag line drip irrigation system was conducted to evaluate the field level operation and management of these systems. Growers were identified through extension outreach and collaborating with dealers and installers of these systems. The survey addressed as installed system design, operational advantages and disadvantages and grower measured/perceived water use and savings. To Date, the survey has been completed by five growers.

System Design

One grower converted all 8 spans of his pivot to drip irrigation. The other two growers installed one and two spans on their existing center pivots, converting from LESA and LEPA water application technologies. Two growers installed the system on new pivots. Design of the systems varied. Factors such as crop type, planting layout (ie straight or circle rows), and designer/installer influenced the design. One type uses a secondary pvc manifold positioned below the pivot main which is held in place by guidewires attached to each pivot tower span. A series of pvc pipes or flexible pivot drop hose were used to connect drip lines to the manifolds. Systems either have a 30 to 80 inch drop/drip line spacing. Drip line length varies based upon the flow rate needed and is matched to the pivot printout. These three systems used Netafim DripNet PC Dripline. Drip line flow rates varied from 1 gallon per hour per foot to 2 gallons per hour per foot.

Figure 1. Example Design of Manifold Assembly.

Filtration and pressure regulation are typically standard practice when operating conventional drip irrigation systems. However, the use of filtration and pressure regulation varied across all the installed systems. Four of the systems evaluated had filters installed. Filter location varied from one at each drip line to only 1 from each pivot drop to the manifold. Pressure regulation also varied and 4 of the systems had pressure regulators on each drop/drop line. All three installations used pressure compensating drip tubing.

System Operation & Maintenance

None of the growers reported any major maintenance problems with their systems. One grower reported that the plugs on the end of the drip lines would pop off during operation. The original compression plugs were later switched out and replaced with “twist-locking” caps and no further problems were reported. Three growers reported some minor rodent damage to the drip tubing that required repair.

The growers expressed two operational concerns about the system. Adjusting the drip lines when changing pivot direction was required to avoid damaging the crop or having the dripline become entangled in the crop canopy. One grower noted that he had to move the move the drip lines by hand at the end of the field so he could perform tillage operations. One grower expressed the interest/need to roll up the drip lines in the winter to prevent damage and make moving the pivot much easier.

Figure 2. Drag-line system parked on end of field.

Figure 3. Drag Line System Design from the pivot mainline

Figure 4. Drag Line System Design as with 2 drip lines per pivot drop.

Advantages and Disadvantages

The biggest advantage all three growers found with the use of the drag-line systems was the decreased depth of wheel tracks compared to sprinkler irrigation. One grower noted the ability to irrigate during colder weather and avoid freezing concerns. Growers also noted that use of drip irrigation reduced runoff from the field and evaporative and/or wind losses from sprinklers.

(a)  (b) 

Figures 5a & 5b. Pivot Wheel Tracks.

One grower noted his advantage to use of the system is being able to maintain use of his pivot and maintain irrigated operation as pumping capacity decreased to flowrates that were difficult to maintain with a sprinkler package system.

Figure 6. Drip line being dragged along crop row, Field Planted in Circle.

Figure 7. Drip line being dragged across crop rows, Field Planted Square.

The biggest problem observed by the grower who did not plant his crop in a circle was that the drip lines would pull across the top of the crop canopy (cotton plants) when traveling perpendicular to the rows. The grower did note some leaf damage but could not verify if it impacted crop yield.


Figure 8. Drip line being dragged over crop canopy.

Water Use and Yield

Not all growers in the survey were able to provide details of their water use and yield. Some challenges to survey water use were experienced due to the above normal rainfall received during the 2017 growing season. Figures 9 & 10 summarize the frequency and total depth of rainfall received during the growing season.

For the grower in the Brazos Valley, he applied 3 irrigation events of an estimated 1 inch of water per irrigation to his cotton crop. Average yield of the field was 1.5 bales per acre, respectively. Grower noted that rainfall had a severe impact on crop quality and yield. Another grower in the high plains used the system to operate for a total of 498 hours to apply about 2.2 inches of preseason water for his field, however the crop did not come to harvest due to damage from a hail storm. One grower was able to produce water use and yield records from 2016. He ran the system for 96 days total and the system had a flow rate of 360 gallons per minute. This resulted in a total of 15.27 inches of water being applied and a corn crop yield of 236 bushels per acre.

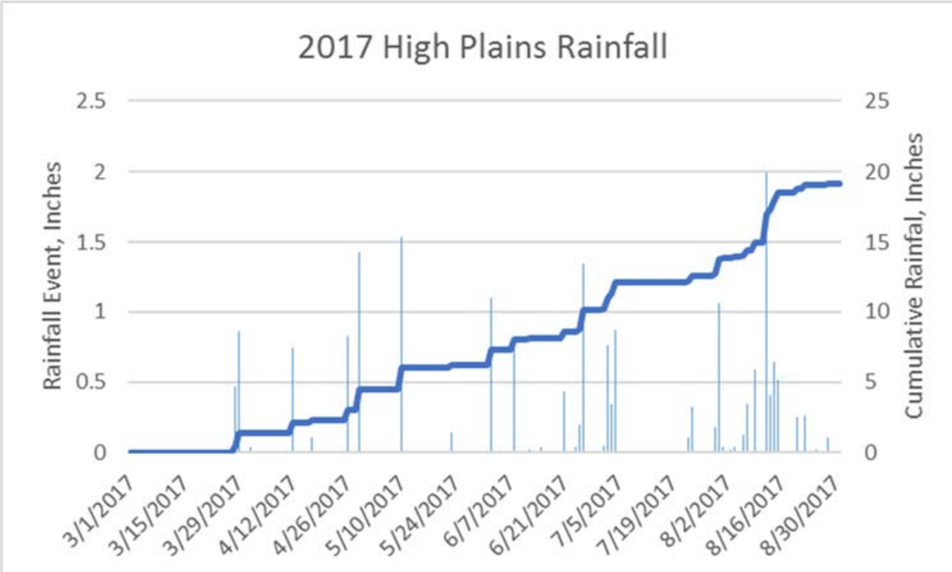

Figure 9. 2017 High Plains Rainfall Summary

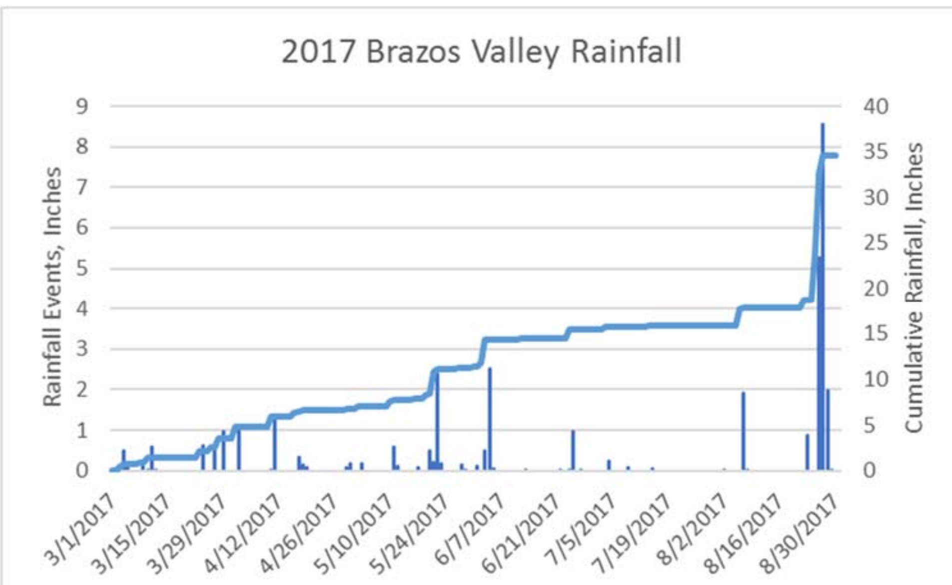

Figure 10. 2017 Brazos Valley Rainfall Summary

Conclusion

Many growers in Texas are interested in adopting the drag-line drip irrigation concept on their farms but have reservations regarding the performance, operation, management and costs. The information collected from the three growers is helpful in addressing potential grower concerns. Further evaluation and documented successful systems are needed before many growers will implement this system. As all systems had different designs, further evaluation of each systems design using different types of manifolds and drops is needed to determine which design is the most practical and cost beneficial for converting existing systems.